Space Weather Technical Forecast

Issued on Saturday, 10 August 2024 at 13:18 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Further M-class flares expected with a chance of isolated X-class flares. Occasional G1-G2/Minor to Moderate geomagnetic storms likely, mainly today and tomorrow (10-11 Aug) with a reduced chance on Days 3-4 (12-13 Aug).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate with multiple M-class flares observed in the past 24 hours. The largest flare was an M5.3 originating from AR3780 at 10/0237UTC. An M4.5 from AR3777 at 09/2123UTC was also observed. There are currently nine numbered sunspot regions on the disc, and two as yet unnumbered, with a large number of these currently magnetically complex or very complex. AR3780 (Fko/beta-gamma-delta) remains the largest region on the disc and has produced flare activity, but AR3784 (Dkc/beta-delta) is statistically the most likely to produce a significant flare. However, AR3777 (Fai/beta-gamma) has been the most active over recent days, and AR3774 and AR3781 (Dso/beta-delta) have also contributed to flare activity, despite AR3774's simpler magnetic structure (Eai/beta). AR3782 is also a region to note, due to its recent growth in spot number and magnetic complexity (now classified as Fai/beta-gamma).

The M4.5 flare produced a CME, with analysis suggesting an arrival time at Earth for late Day 3 (12 Aug) or more likely early Day 4 (13 Aug). Analysis is underway to assess the CME given off in association with the M5.3 flare at 10/0237UTC.

Solar Wind / Geomagnetic Activity: Slow-ambient solar wind conditions mostly persisted through the period, although wind speeds did occasionally briefly touch into slightly elevated levels. Winds generally stayed between 360-410km/s. Density remained at or below average. Interplanetary Magnetic Field, Bt, was weak at 6nT or below. The north-south component varied weakly, between -5nT and +5nT. Phi angle was negative (towards the Sun). Geomagnetic activity was Quiet (Kp1-2).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 remained at background below the S1 Minor Radiation Storm threshold. High energy electron flux (greater than 2MeV) observed at GOES16 were predominantly at background levels. The 24-hour fluence was steady well below the Active threshold, with 1.69e6 integrated pfu observed at 10/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High solar activity is forecast, with occasional M-class flares expected and a slight chance of isolated X-class flares.

Solar Wind /Geomagnetic Activity: There is potential for multiple CMEs to arrive today (10 Aug), but confidence remains low due to the complex nature of their analysis. A CME associated with the X1.3 flare at 08/1935UTC, which also produced a complex halo, has been analysed to have an Earth directed component and may arrive at Earth later Day 2 (11 Aug). A CME associated

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with the M4.5 flare at 09/2123UTC is also forecast to have an Earth directed component, arriving late Day 3 (12 Aug), or more likely early on Day 4 (13 Aug). A further CME from the M5.4 flare at 10/0237UTC is awaiting analysis.

CME influence is likely at times throughout the forecast period, however overall confidence in the CME forecast is low. Geomagnetic activity is expected to be mostly Quiet (Kp1-2) in the absence of any CME arrivals, with a slight chance of isolated Unsettled intervals (Kp3). For Days 1-2 (10-11 Aug) occasional G1-G2/Minor to Moderate Storming (Kp5-6) intervals are likely in association with CME arrivals, with a slight chance of G3/Strong (Kp7) storms. This risk decreases slightly going into Days 3-4 (12-13 Aug), but further CME arrivals remain likely.

Energetic Particles / Solar Radiation: High energy proton flux, as observed by GOES-18, is expected to persist at background throughout the period. Any strong flares will bring the potential for a slight chance of reaching/exceeding the S1 Minor Radiation storm level. The high energy electron flux is forecast to be at mostly background levels. The associated 24-hour fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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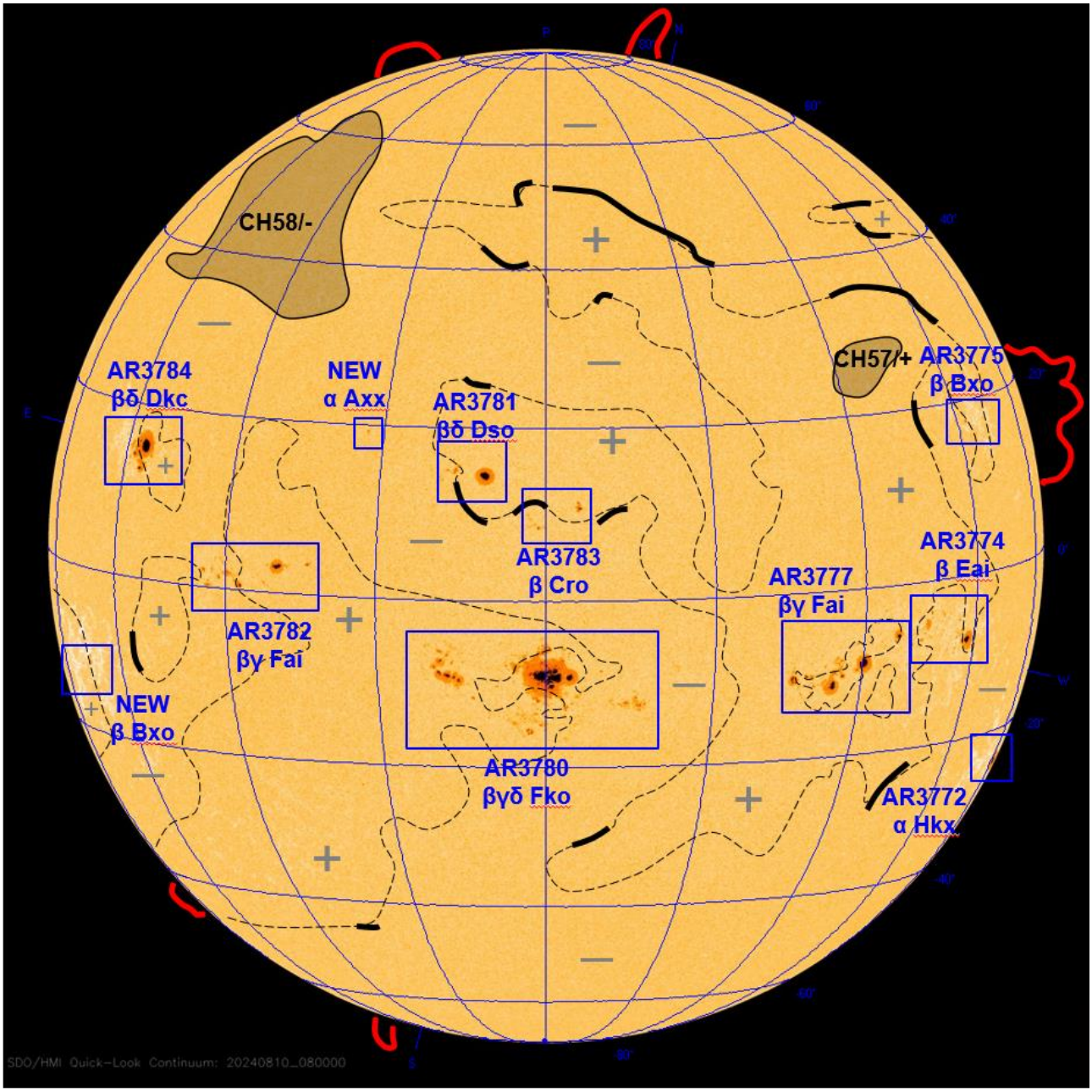
Figure 1. Solar Analysis Valid 10/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Multiple CMEs left the Sun on 07 Aug, with one or more forecast to give Earth a glancing blow today (10 Aug). Initial assessment proved complicated due to the complex halo nature of two of the CMEs, as well as a coincident far-sided CME around a similar time. These CMEs may interact or combine together, meaning there is low confidence in their arrival time and strength.

A CME associated with the X1.3 flare from AR3774 at 08/1935UTC also produced a complex halo, which has been analysed to have an Earth directed component. This CME has the potential to arrive at Earth later tomorrow (11 Aug) though there is considerable uncertainty due to the challenging analysis.

Another CME is also in the forecast with an Earth-directed component, in association with the M4.5 flare from AR3777 at 09/2123 UTC. This produced a partial halo CME alongside a Type II radio emission (estimated velocity 606km/s). Analysis suggests an arrival late on Day 3 (12 Aug), or more likely early on Day 4 (13 Aug).

A further CME was observed in association with an M5.3 flare from AR3780 at 10/0237UTC. Analysis is underway to determine if this is Earth directed.

It is likely there will be some CME influence at times through the entire forecast period, though overall confidence in the forecast is low. Solar winds in Enlil are currently too high compared to actual values, and this will have some influence in determining arrival times of any CMEs.

Geomagnetic activity is expected to be mostly Quiet (Kp1-2) in the absence of any CME arrivals, with a slight chance of isolated Unsettled intervals (Kp3). For Days 1-2 (10-11 Aug) of this forecast period, occasional G1-G2/Minor to Moderate Storming (Kp5-6) intervals are likely in association with CME arrivals, with a slight chance of G3/Strong (Kp7) storms. This risk decreases slightly going into Days 3-4 (12-13 Aug), but further CME arrivals remain likely.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	70	70	40	40
Strong	G3	No	15	15	5	5
Severe	G4	No	1	2	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
07/1820	Partial	M4.5	SW – AR3774	660 km/s	10/0600 UTC	Low confidence due to far-sided event interfering with analysis.

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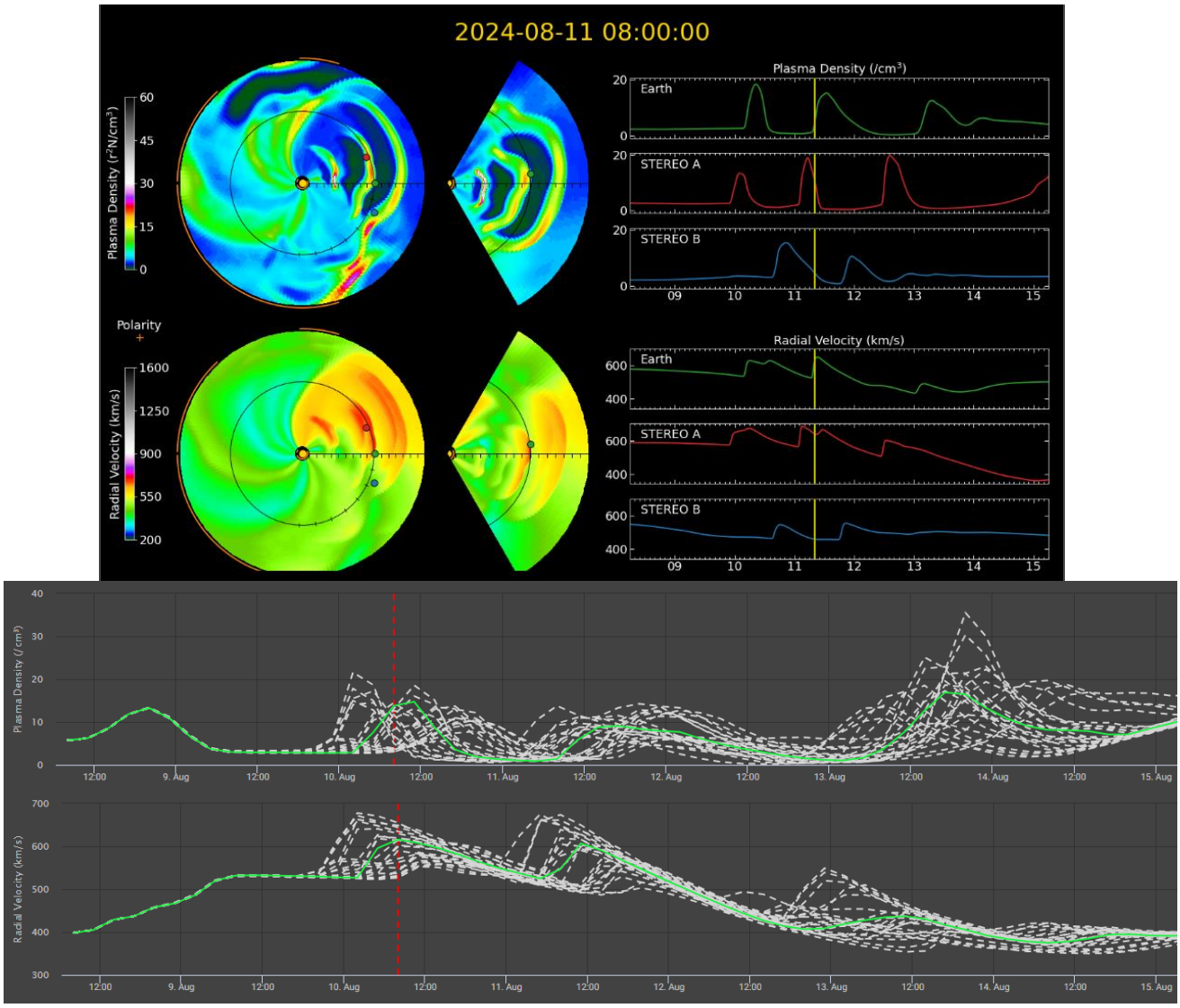
09/0001	Full	X1.3	SW – AR3777	750 km/s	11/1600 UTC	Complex halo causing a difficult analysis, hence low confidence.
09/2123	Partial	M4.5	SW – AR3777	633 km/s	Late 12 – early 13 Aug	Partial halo, difficult analysis once again so low confidence.

Figure 2: MOSWOC Enlil and Ensembles model, showing CME arrivals through the forecast period.



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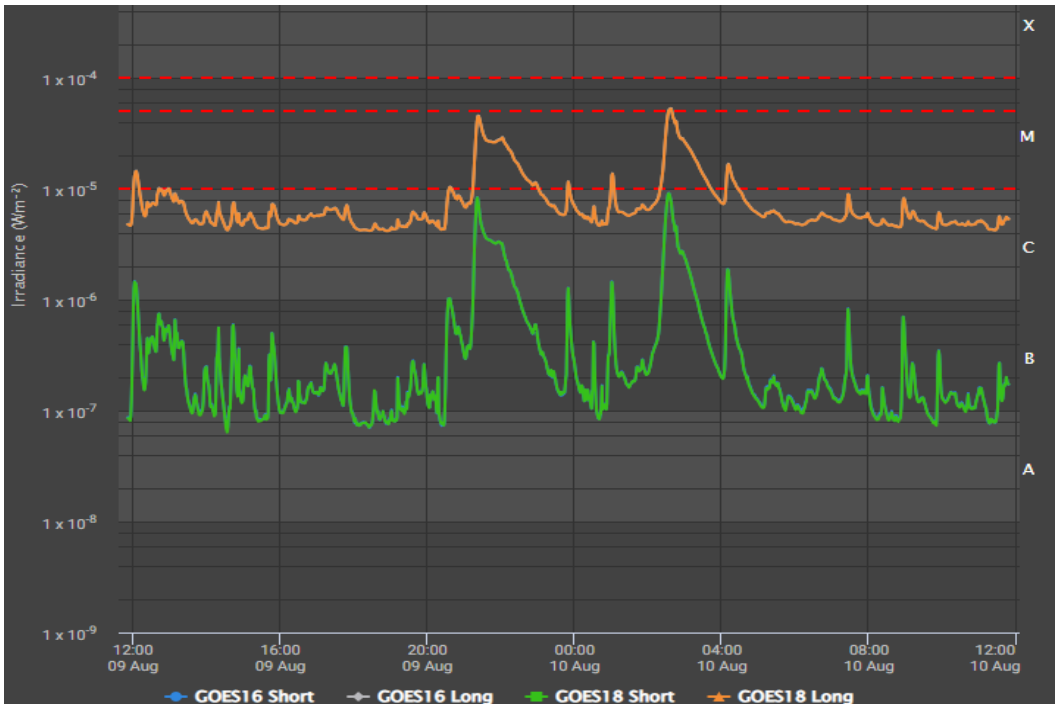
Radio Blackouts - X-Ray Flares:

Solar activity has been Moderate with multiple M-class flares observed in the past 24 hours. The largest flare was an M5.3 originating from AR3780 at 10/0237UTC. An M4.5 from AR3777 at 09/2123UTC was also observed. There are currently nine numbered sunspot regions on the disc, and two as yet unnumbered, with a large number of these currently magnetically complex or very complex. AR3780 (Fko/beta-gamma-delta) remains the largest region on the disc and has produced flare activity, but AR3784 (Dkc/beta-delta) is statistically the most likely to produce a significant flare. However, AR3777 (fai/beta-gamma) has been the most active over recent days, and AR3774 and AR3781 (Dso/beta-delta) have also contributed to flare activity, despite AR3774's simpler magnetic structure (Eai/beta). AR3782 is also a region to note, due to its recent growth in spot number and magnetic complexity (now classified as Fai/beta-gamma).

Further M-class flares are expected with a slight chance of an isolated X-class flare.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 3: GOES-16 & -18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):
High energy proton flux, as observed by GOES-18, was at background throughout the period. Any strong flares will bring the potential for a slight chance of reaching/exceeding the S1 Minor Radiation storm level, especially from AR3774 and AR3777 as they are currently in the western hemisphere, and also from AR3780 as it rotates into the western hemisphere later in the forecast period.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

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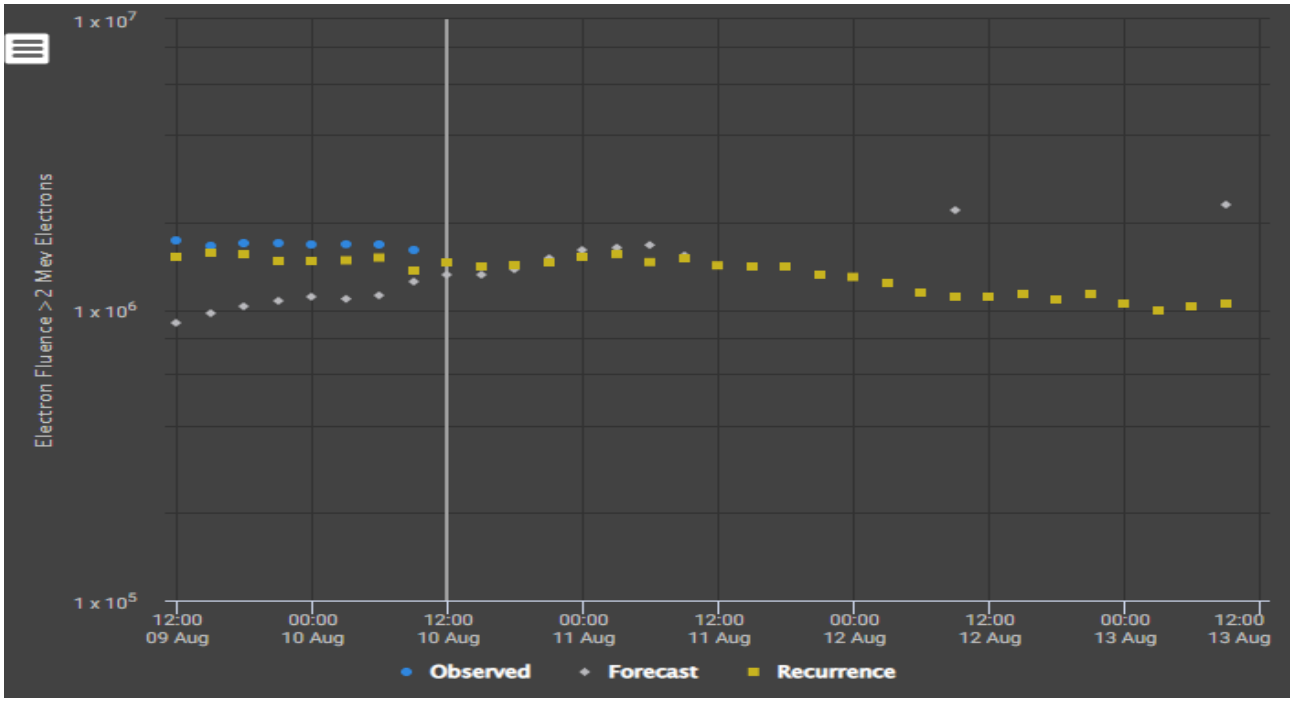
High Energy Electrons Event (≥ 2MeV):
High energy electron flux, as observed by GOES-16, is currently at background. In the absence of any notable fast wind arrivals, the observed flux is expected to remain at or near background level.

The associated 24hr electron fluence is expected to remain below Active (1e8 integrated pfu).

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 4: MOSWOC REFM.



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